

REMARKS

Claims 1-7 are pending in the present Application. No claims have been canceled, claims 1-7 have been amended, and claims 8-9 have been added, leaving Claims 1-9 for consideration upon entry of the present Amendment.

I. The drawings have been respectfully amended.

The applicant respectfully thanks the Examiner for recommending drawing changes which have implemented herein.

Specifically, Fig. 1 Reference Numeral "2a" has been corrected to point to the surface of Si substrate 2.

Additionally, Figs. 10(A) and 10(B) are indicated to be "PRIOR ART."

No new matter is added.

II. The obviousness rejections of claims 1, 2, and 4 based on Suzuki (JP 2003-017684) in view of Imahashi (US 5,338,362), as noted on page 3 of the Office Action.

The USPTO respectfully rejects claims 1, 2, and 4 under 35 U.S.C. § 103(a) as being unpatentable over Suzuki in view of Imahashi. Claim 1 is an independent claim.

A. The cited references do not teach or suggest removing impurities at a temperature greater than 500°C, as claimed in claim 1.

Claim 1 claims in relevant part:

~~"and a step of removing impurities from the insulating film are repeated a plurality of times, wherein the removing impurities is~~
performed at a temperature greater than 500°C, to form an insulating film having a prescribed thickness." (emphasis added)

No new matter is added by the amendments. Support for this amendment can be found at least in the specification at page 9, lines 25-26. Applicants respectfully note that Claims 2-7 have been amended for consistency with Claim 1. Regarding these limitations of claim 1, it is respectfully not seen where the cited references teach or suggest the claimed method quoted above.

Specifically, the USPTO respectfully states on page 3 of the Office Action that "Suzuki shows a method for forming an insulating film in a semiconductor device

characterized in that a step of forming an insulating film and a step of removing impurities from the insulating film are repeated a plurality of times, to form an insulating film having a prescribed thickness.”

However, the USPTO notes that "Suzuki fails to show that the insulating film is formed to have a thickness of .3 to 2nm each step"

Therefore, to make up for these deficiencies in Suzuki, the USPTO respectfully cites Imahashi as teaching: "that an insulating film may be formed in intervals in which 5 angstroms of insulating layer is deposited during each interval."

In response, it is respectfully noted that Claim 1 has been amended to claim a method comprising removing impurities at a temperature greater than 500°C. It is respectfully asserted that neither Suzuki nor Imahashi disclose, teach or suggest :

~~“and a step of removing impurities from the insulating film are repeated a plurality of times, wherein the removing impurities is performed at a temperature greater than 500°C, to form an insulating film having a prescribed thickness.”~~

as claimed in Claim 1.

Thus, the references do not teach or suggest all of the limitations of Claim 1 either inherently or impliedly. Therefore, the obviousness rejection is respectfully overcome as discussed in more detail below.

For example, Suzuki does not disclose a temperature greater than 500°C. Rather, Suzuki teaches 500 °C or less (See para 0013). **In fact, Suzuki “teaches away” from removing impurities using a temperature higher than 500 °C.** Specifically, Suzuki explicitly teaches that at a temperature higher than 500°C, an adverse reduction of the gate dielectric film will occur (see para 0013). Thus, Suzuki “teaches away” from using temperatures higher than 500°C because Suzuki teaches reduction of gate dielectric films above 500°C.

Imahashi also does not disclose, teach or suggest **removing impurities using a temperature higher than 500 °C.** Thus, Imahashi does not make up for the deficiencies of Suzuki.

B. Additional points regarding the obviousness rejection of claim 1 in view of the combination of Suzuki and Imahashi and secondary considerations.

Additionally, as discussed above at section A, the USPTO notes that “Suzuki fails to show that the insulating film is formed to have a thickness of 0.3 to 2 nm each step”

Therefore, to make up for these deficiencies the USPTO respectfully cites Imahashi as teaching: “that an insulating film may be formed in intervals in which 5 angstroms of insulating layer is deposited during each interval.”

In response applicants respectfully note that, Imahashi teaches “three thousand film forming processes are repeated” to result in a film of thickness of 1.5 micrometers. (Imahashi, Col. 8, lines 38-40). As presently claimed in claim 1 herein, impurities can be removed if the film thickness is less than 2 nm (see p. 8, line 4). If thicker films are used, impurities remain in the film. (Specification, p. 6, lines 27-28). Thus, because Imahashi teaches films greater than 2 nm (i.e., 1.5 micrometers is greater than 2 nm), one of ordinary skill in the art would not have a reasonable expectation of success modifying Suzuki in view of Imahashi to form an impurity free film.

Additionally, Applicants have disclosed unexpected success in forming insulating films with reduced impurities, as is disclosed in Table 1 at page 13 of the present specification. The applicant also discloses unexpected success in improved dielectric breakdown voltage, as is disclosed in Table 3 at page 18 of the present specification. The references do not disclose these unexpected results; thus one of ordinary skill in the art would not have been logically prompted to form insulating films by the claimed method.

Thus, the cited references, taken either alone or in combination, do not teach or suggest all of the limitations of Claim 1, and the cited references actually teach away from the claimed method. Additionally, the references do not teach or suggest applicants’ unexpected results.

Therefore, it is respectfully asserted the references do not establish a *prima facie* case of obviousness as discussed in MPEP 706.02(j), thus the claims are patentable over Suzuki and Imahashi. Reconsideration and withdrawal of the rejections are respectfully requested.

C. The dependent claims.

As noted above, it is respectfully asserted that independent claim 1 is allowable, and therefore it is further respectfully asserted that dependent claims 2 and 4 are also allowable.

III. The obviousness rejections of claims 3 and 5-7 based on Suzuki (JP 2003-017684) in view of Imahashi (US 5,338,362) and further in view of Yamazaki (2002/0006711).

The USPTO respectfully rejects claims 3 and 5-7 under 35 U.S.C. § 103(a) as being unpatentable over Suzuki in view of Imahashi further in view of Yamazaki.

A. Independent claim 1 is respectfully asserted to be allowable.

As noted above, it is respectfully asserted that independent claim 1 is allowable, and it is further respectfully asserted that Yamazaki does not overcome the deficiencies in Suzuki and Imahashi noted above in Section II regarding claim 1. Therefore, it is further respectfully asserted that dependent claims 3 and 5-7 are also allowable.

B. Further explanation regarding dependent claim 3.

Claim 3 stands rejected under 35 U.S.C. § 103(a) as obvious over Suzuki in view of Imahashi as applied to claims 1 and 2 above and further in view of U.S. Patent Application 2002/0006711 to Yamazaki. The USPTO respectfully notes on page 5 of the Office Action that Suzuki as modified by Imahashi fails to teach, pertaining to claim 3, that the step of removing impurities is performed in reducing gas atmosphere combined with oxidizing gas atmosphere, but asserts that Yamazaki teaches in [0026] that both hydrogen and oxygen are mixed and supplied to a substrate to remove impurities in the substrate. Thus the USPTO respectfully argues that it would have been obvious to one of ordinary skill in the art to use a combination of hydrogen as a reducing gas and oxygen as an oxidizing gas, as taught by Yamazaki.

It is respectfully noted that Claim 3 has been amended to further claim a first treatment in a reducing atmosphere and a second treatment in an oxidizing atmosphere. Support for this amendment can be found at least in the present Specification as originally filed on page 9, lines 15-16, page 10, lines 1-2. No new matter has been added.

Claim 3 claims a first treatment in a reducing gas atmosphere and a second treatment in an oxidizing gas atmosphere. Thus Claim 3 **claims use of a reducing gas before use of an oxidizing gas.**

It is respectfully noted that Yamazaki does not disclose use of a reducing gas before use of an oxidizing gas. Rather, Yamazaki discloses “First, carbon impurities ... are removed using ... oxygen, and thereafter the carbon impurities ... can be removed by ... hydrogen” [0026]. Yamazaki also discloses that hydrogen and oxygen can be mixed.

Additionally, Yamazaki teaches carbon and oxygen react to form CO_x gaseous species at [0022]. Gasification of carbon impurities can leave “single bonds,” which Yamazaki teaches can be removed by treatment with hydrogen [0026]. Thus, in view of Yamazaki, one of ordinary skill in the art would have understood use of hydrogen to be useful after or with oxygen. Therefore one of ordinary skill in the art would not be logically suggested by Yamazaki to consider use of a reducing gas before an oxidizing gas.

In addition, Applicants unexpectedly observed control of the interface layer can be accomplished when the first anneal (heat treatment) is performed in a reducing gas atmosphere, see page 8, lines 26-28 of the present specification.

Thus the combination of Suzuki, Imahashi and Yamazaki does not disclose, teach or suggest the limitations of Claim 3 either inherently or impliedly. The references also fail to provide a reasonable expectation of success that the disclosed method would be provided by a combination of the references. Thus, Claim 3 is patentable over Suzuki, Imahashi and Yamazaki.

IV. New Claims.

Claims 8-9 have been added. Support for Claim 8 can be found at least in the present Specification as originally filed on page 8, line 9 and Claim 1. Support for claim 9 can be found in claims 1 and 3. No new matter has been introduced by these amendments.

V. Conclusion.

It is believed that the foregoing amendments and remarks fully comply with the Office Action and that the claims herein should now be allowable. Accordingly, reconsideration and allowance of all of the claims is respectfully requested.

Please contact the undersigned for any reason. Applicants seek to cooperate with the Examiner, including via telephone if convenient for the Examiner.

If there are any additional charges with respect to this Amendment or otherwise, please charge them to Deposit Account No. 06-1130.

Respectfully submitted,

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